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Dry Gas Seal contamination

during operation and pressurized hold
Background and potential solutions

Presenter/Author bios

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Before he was leading the global Technical Sales and Service Support on compressor sealing. He has more than 15 years professional experience in all aspects of compressor gas seals and seal support systems for compressors like application engineering, product management, onsite support and troubleshooting. Daniel Goebel holds a degree in industrial engineering and management of the Munich University of Applied Science.

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Before he was the EagleBurgmann Regional Product Specialist supporting the Americas region with technical and sales support for designing, servicing, repairing, troubleshooting and upgrades of compressors gas seals and systems. His 18-years of experience with gas seals includes instructing a Texas A&M Dry Gas Seal Systems Course and providing input as a member of the API 692 committee developing the standards for compressors gas seals and systems

Abstract

This paper will discuss the challenges with contamination of gas seals. The reliability of gas seals is largely dependent on having a continuous supply of clean and dry seal gas. In dynamic mode, gas supply systems take product gas from a higher-pressure level in the compressor, filter it and use it to create the ideal environment for the gas seal. This typically ensures that the gas seal effectively protected against contaminated process gas.

Compressor gas seals are very robust sealing devices, but the environment needs to be dry and clean. The leading root cause of gas seal failures is contamination. One of the most common sources of contamination is during compressor start up, slow-roll, standstill, or shutdown modes or because the conditioning skid is not sufficient. In these modes, there is a lack of seal gas flow, which suggests no means to produce seal gas flow is available, such as a high-pressure gas source or booster for the seal gas supply. This is where it pays to have a reliable, clean gas supply. Without sufficient seal gas flow, potential contamination will reach the gas seal and impact its operational behavior.

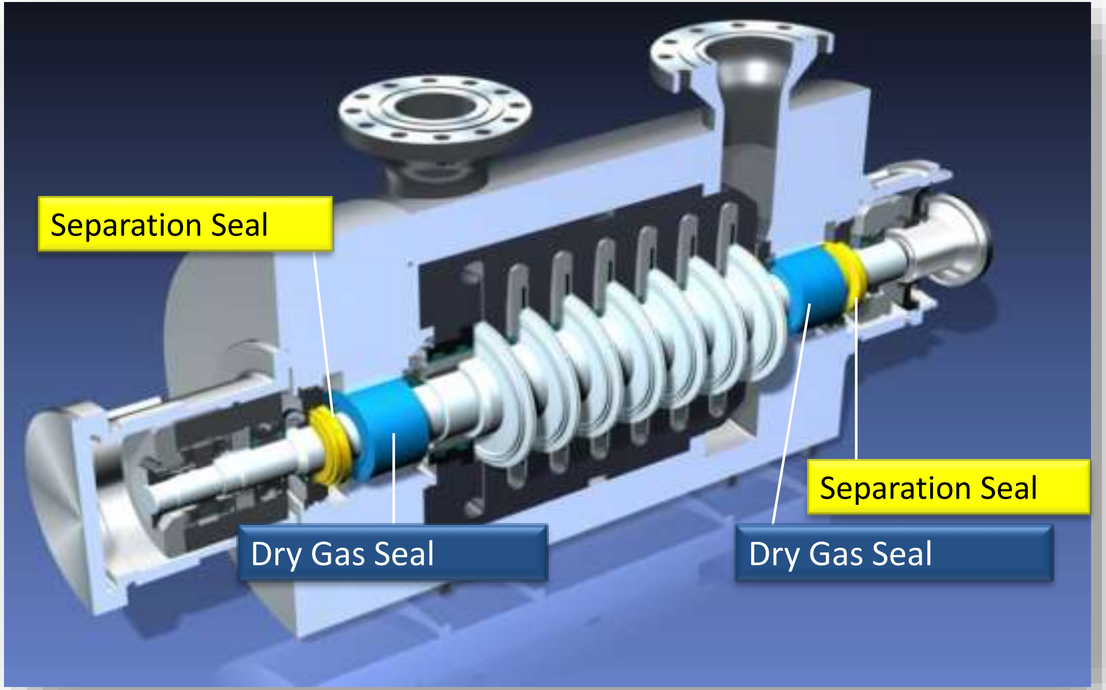
This paper will describe contamination to the gas seal by process gas, during commissioning, by particle and by liquids, caused by inadequate seal gas supply. Then it will focus on different methods of providing seal gas flow during transient conditions. Finally, it will discuss solutions to ensure a reliable, clean gas flow to the seal at all relevant conditions together with additional possibilities to add robustness to gas seals.

Content

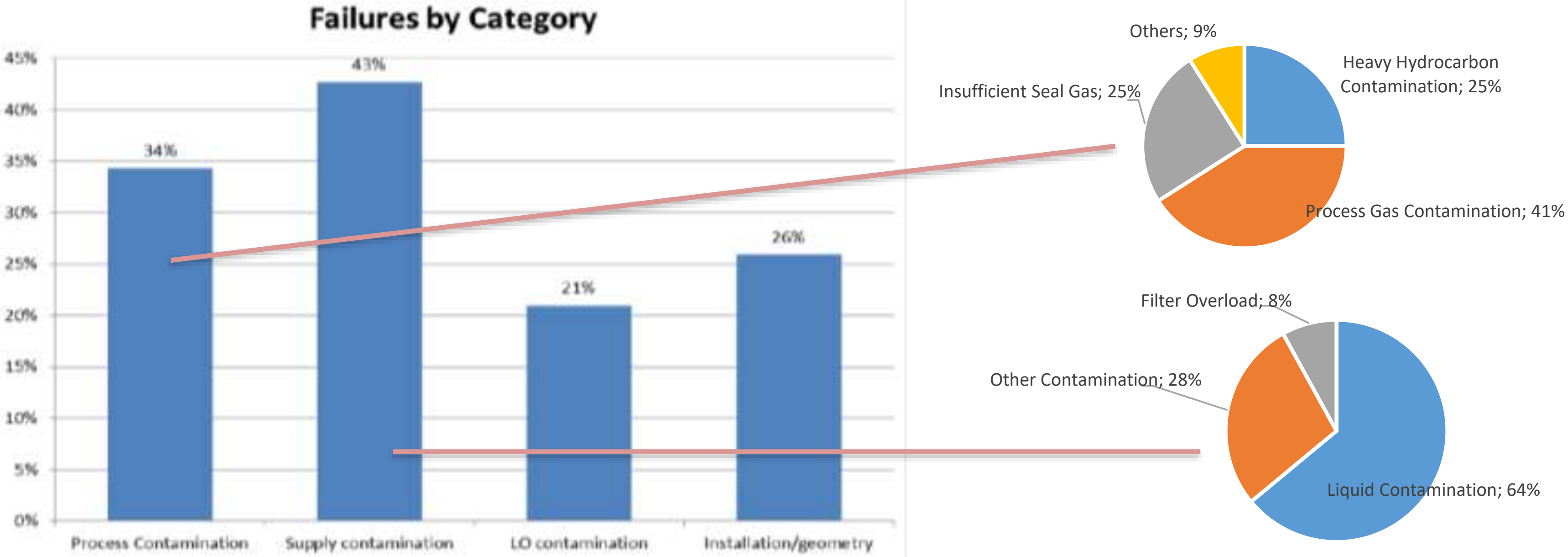
- Introduction
- Contamination by particles & liquids
- Contamination by condensates
- Contamination during pressurized stand still conditions
- Measures to improve reliability

Introduction

- Process gas compressors are essential for production capacities
- Compressors usually have no backup
- State of the art sealing technology are Dry Gas Seals



Introduction

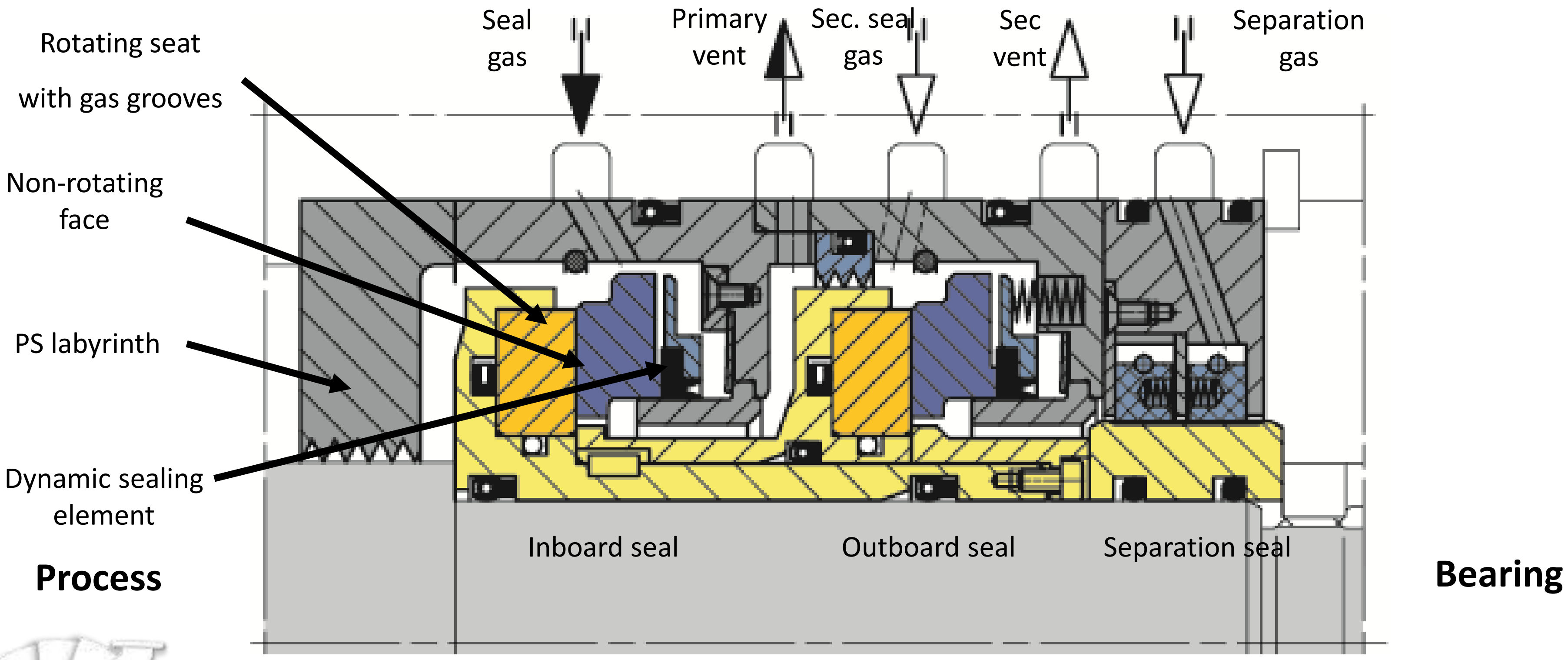


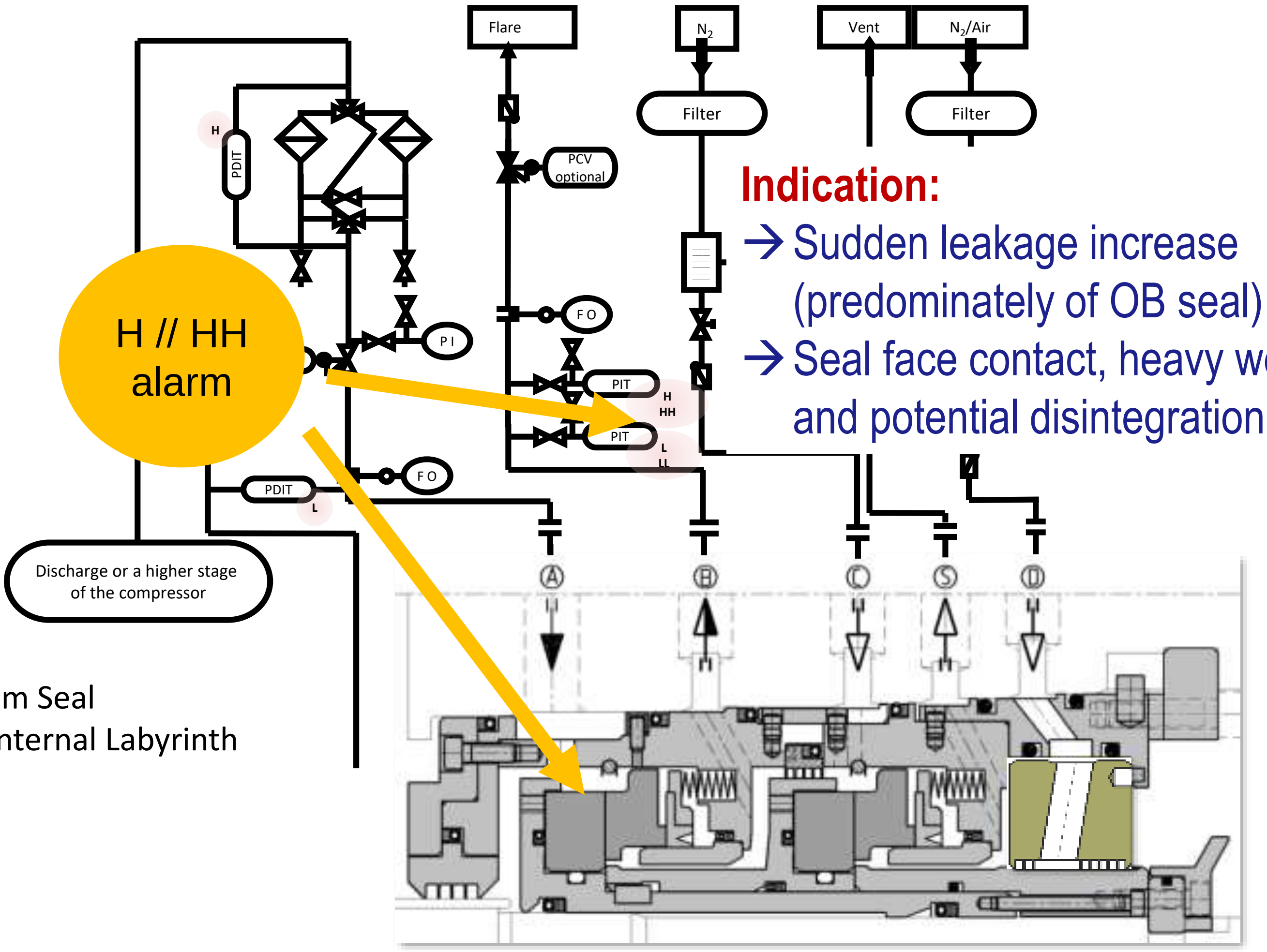
Source: ANALYSIS OF HISTORICAL DRY GAS SEAL FAILURE, VERSION 4.0, December 2015, Gas Machinery Research Council, Southwest Research Institute®

→ Contamination is one of the major root causes of failures

→ The background and solutions are discussed within this presentation

Introduction





Indication:

→ Sudden leakage increase (predominately of OB seal)

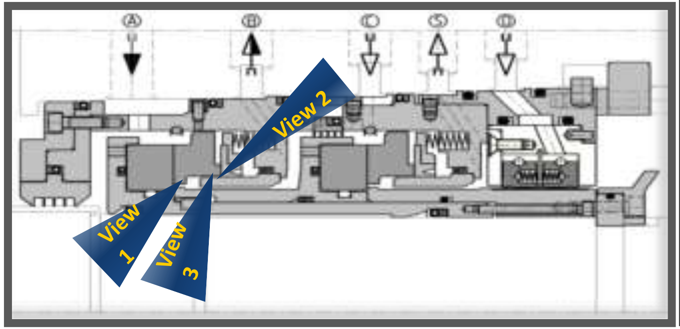
→ Seal face contact, heavy wear and potential disintegration

Tandem Seal
with internal Labyrinth

Gas seal failure due to contamination: heavy HC

Observation:
Fluctuating leakage; continuously increasing leakage trend

<u>Initial cause:</u>
Hang-up or blocking of dynamic secondary seal



Contamination during operation

Contamination

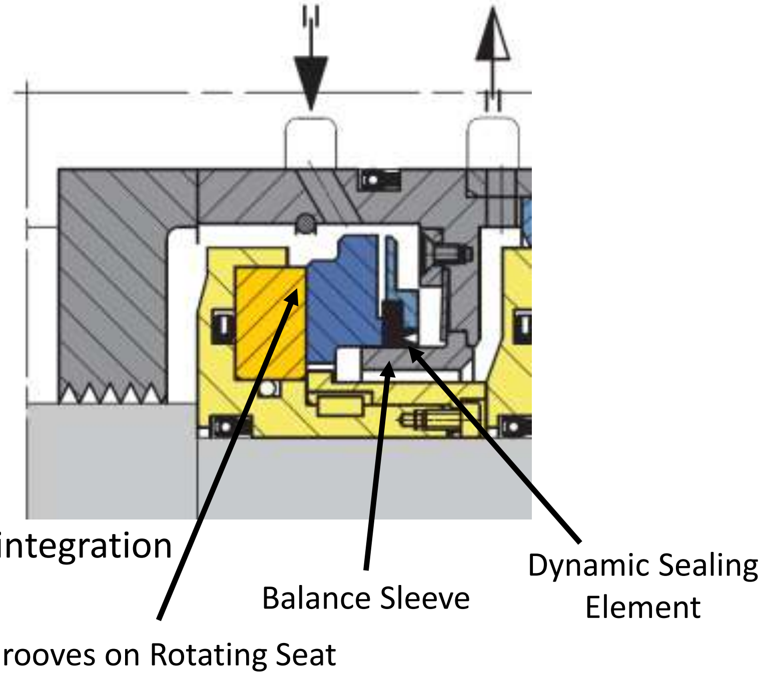
- Particles and liquids
- Condensates
- Too low seal gas flow

Contamination by particles & liquids

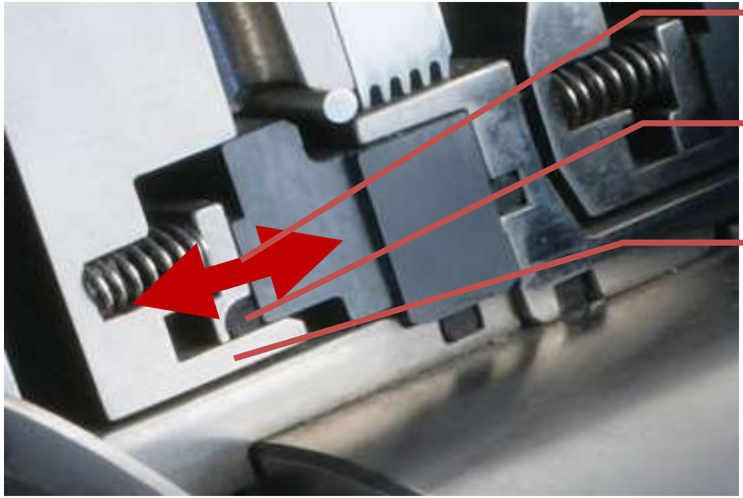
Risks when particles or fluids enter the Dry Gas Seal:

- Contamination of the gas grooves
  → Impact to seal performance and gas film stiffness
  → Decreasing gas seal reliability

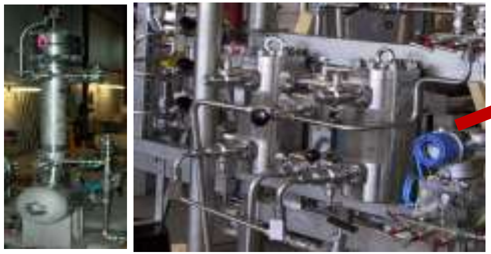
- Contamination of dynamic sealing element
  → Reduction of axial movability
  → Hang up:
    - Open seal gap: high leakage
    - Closed seal gap: high friction / wear and seal disintegration



Contamination by particles & liquids



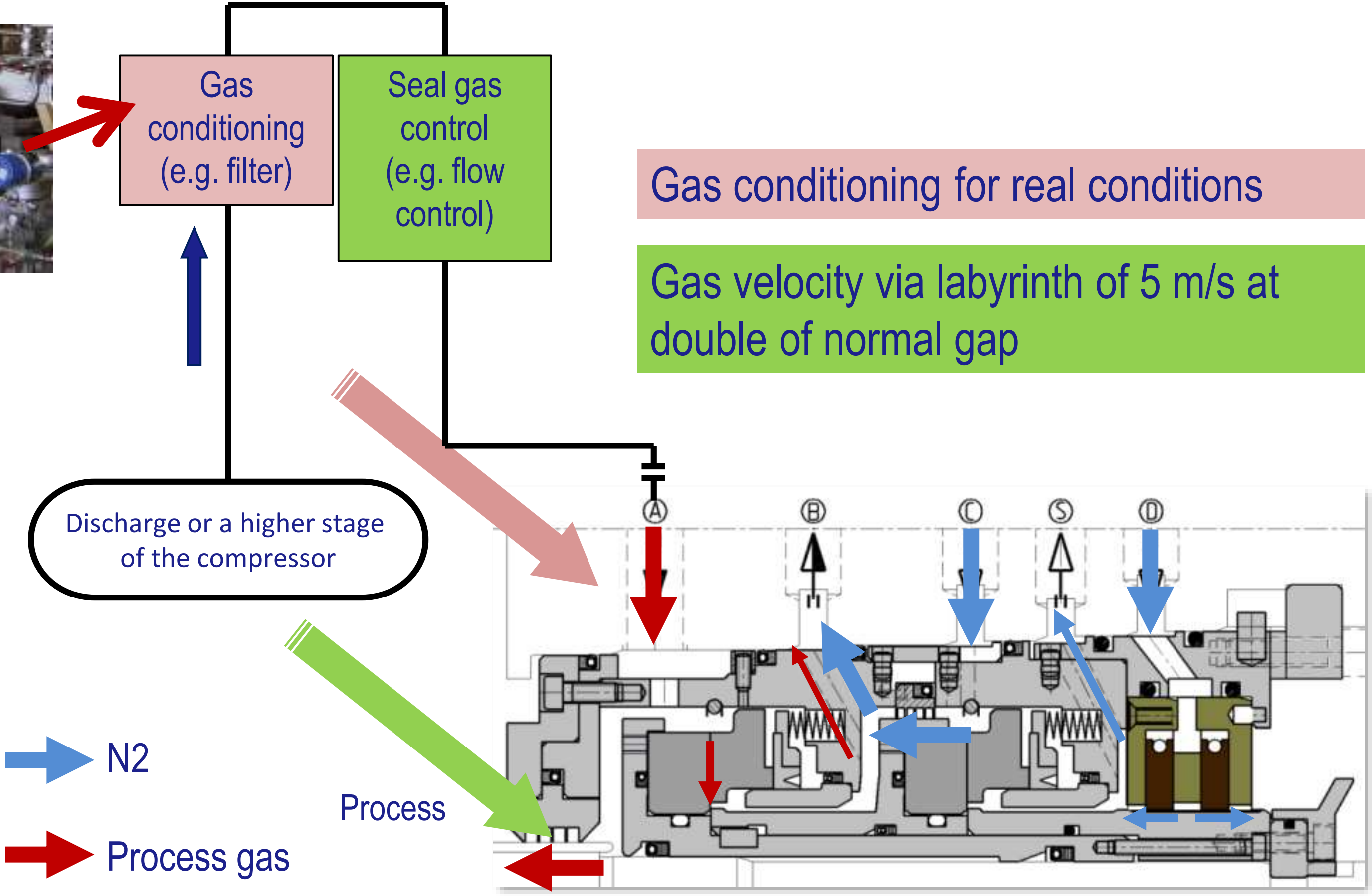
Conclusion – Contamination by particles & liquids



Separator Filter

Gas conditioning for real conditions

Gas velocity via labyrinth of 5 m/s at double of normal gap



- Accurate analysis of process gas & real operating conditions
- Sufficient gas conditioning
- Sufficient seal gas flow

Influence on temperature

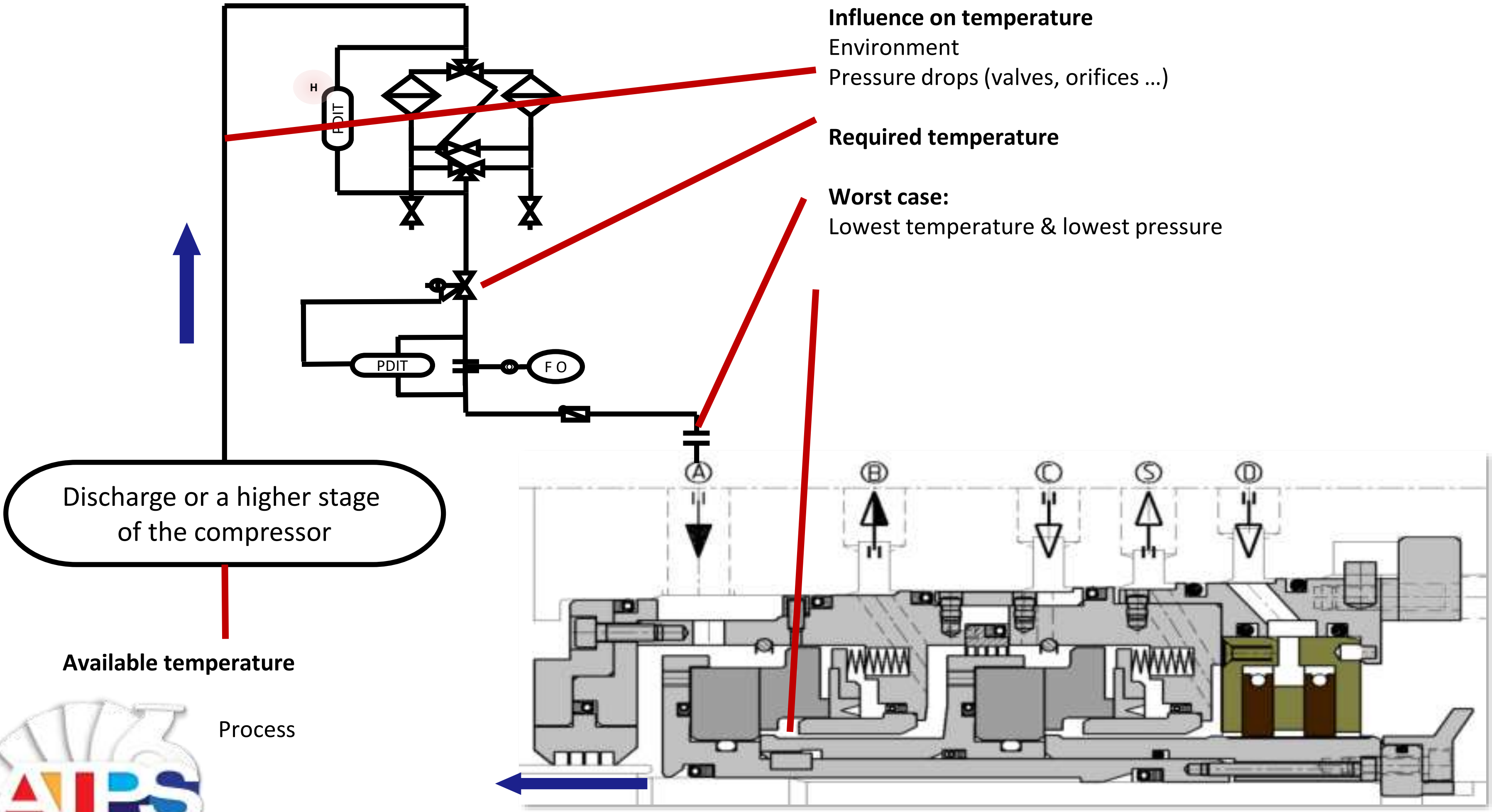
Environment

Pressure drops (valves, orifices …)

Required temperature

Worst case:

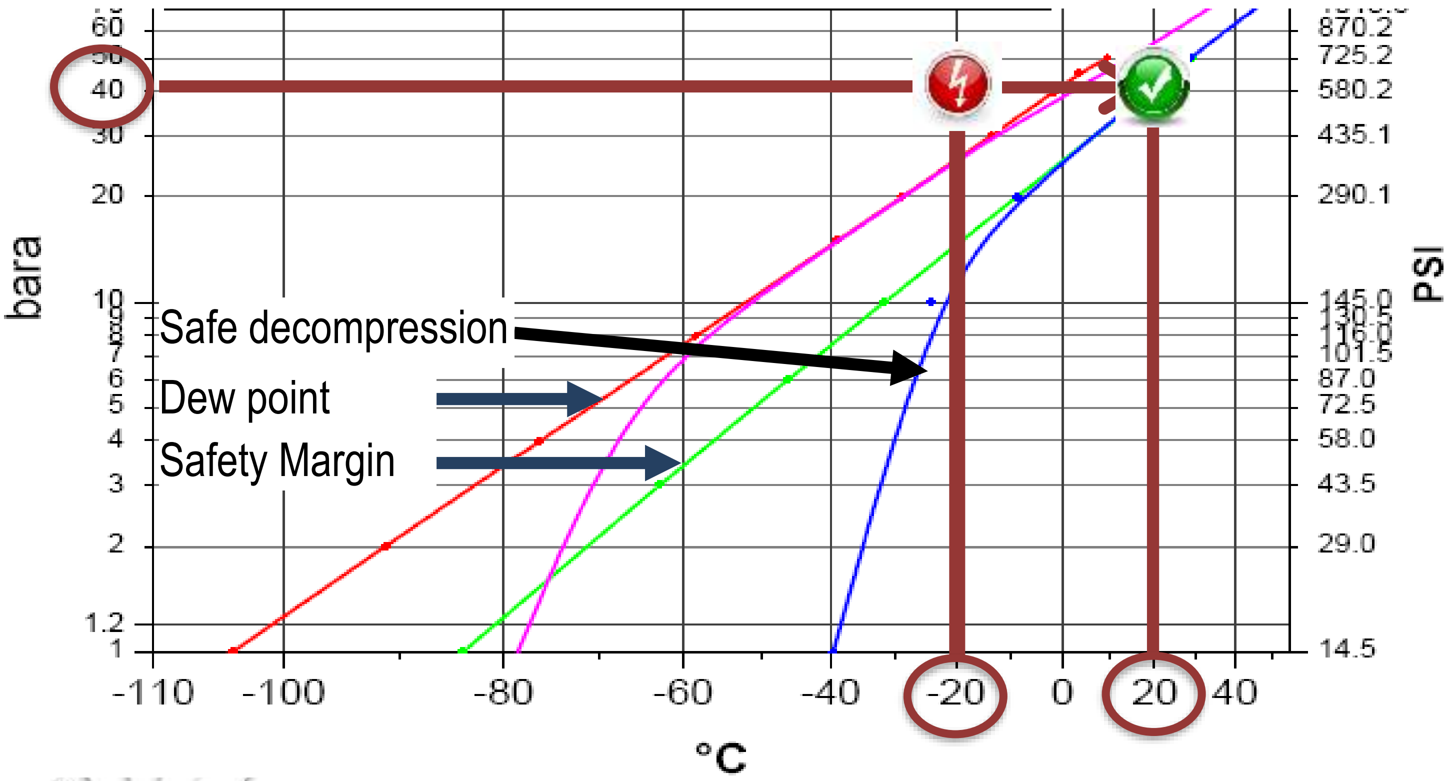
Lowest temperature & lowest pressure



Available temperature

Process

Dew point analysis (specific example)



Safety margin:

20 K

Seal operation has to be above the safe decompression line

Example

SOP: 40 bara

Temperature: -20 °C

→ Condensation risk

→ Heating to min. +20 °C required

Conclusion – Contamination by condensates

Add Heater, heat tracing or isolation

Gas conditioning (e.g. filter)

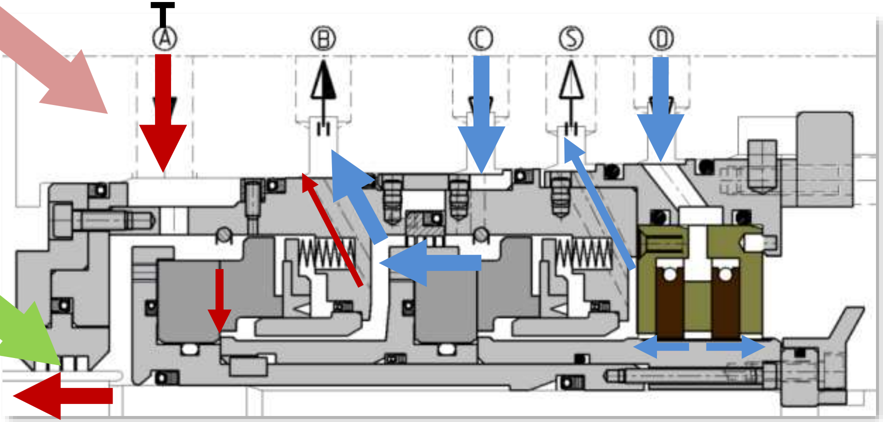
Seal gas control (e.g. flow control)

Gas conditioning for real conditions

Gas velocity via labyrinth of 5 m/s at double of normal gap

– Dew point analyses & heating

Discharge or a higher stage of the compressor



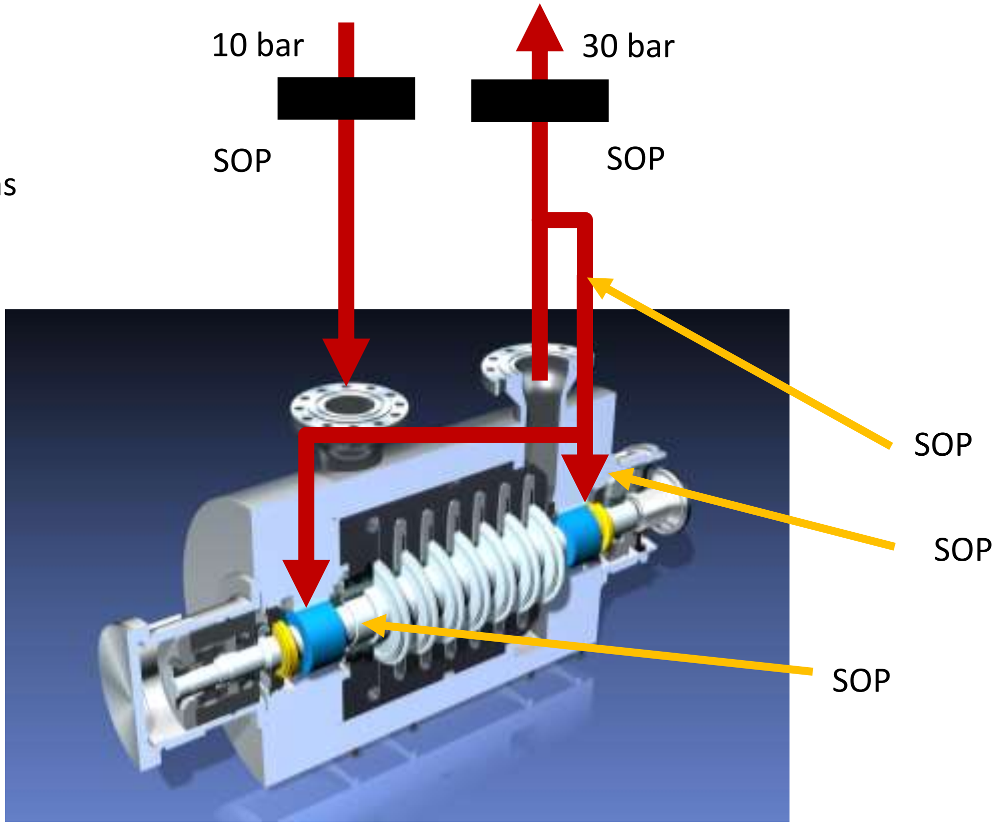
N2

Process gas

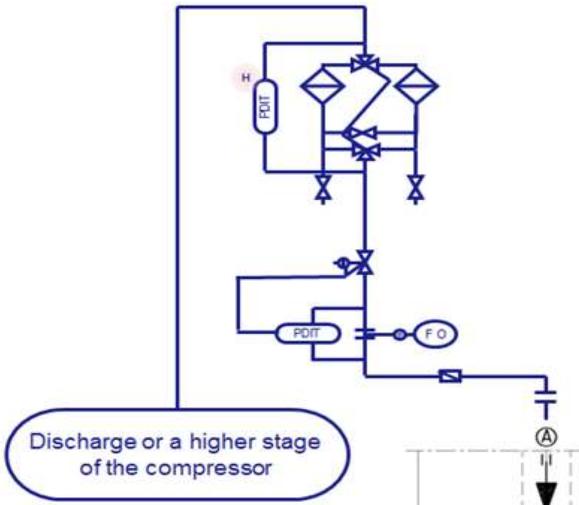
Process

Contamination during pressurized hold

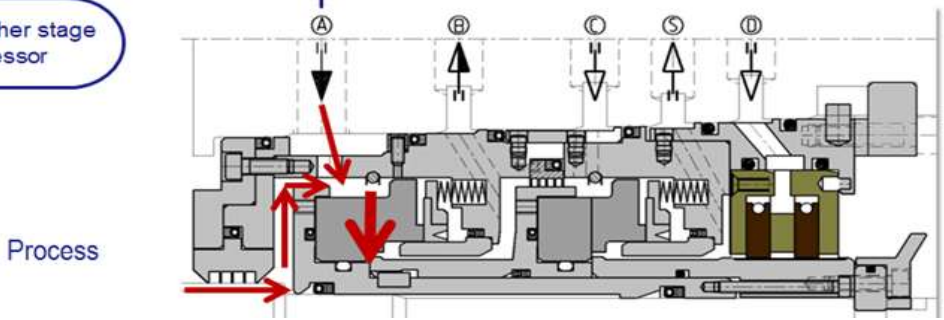
Why?
- Quick restart
- Standby
- Avoid emissions



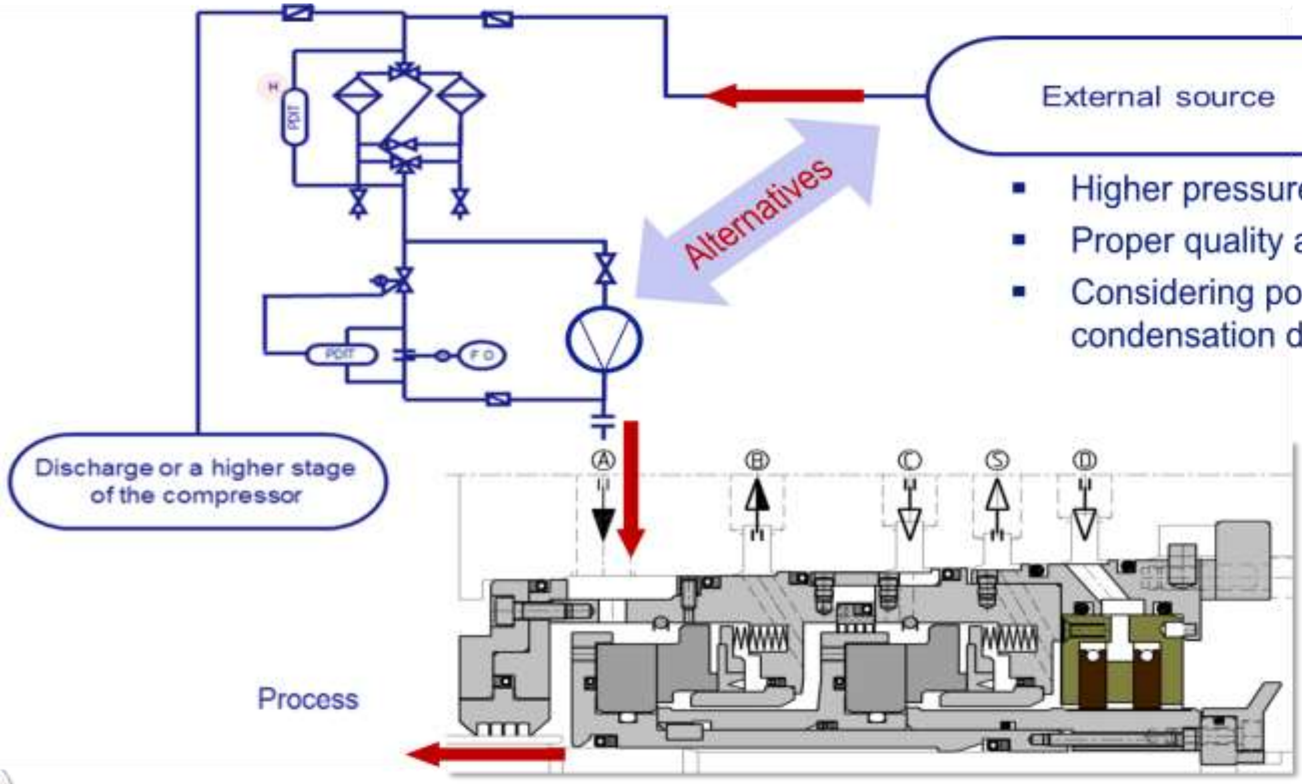
Contamination during pressurized hold



- → Unfiltered process gas will enter and will contaminate the Dry Gas Seal
- → Additionally due to the pressure drop through the sliding faces the gas will cool down
- → Gas temperature will drop from operating temperature to ambient, depending on the standstill time
- → No heating effect of the seal for compensation

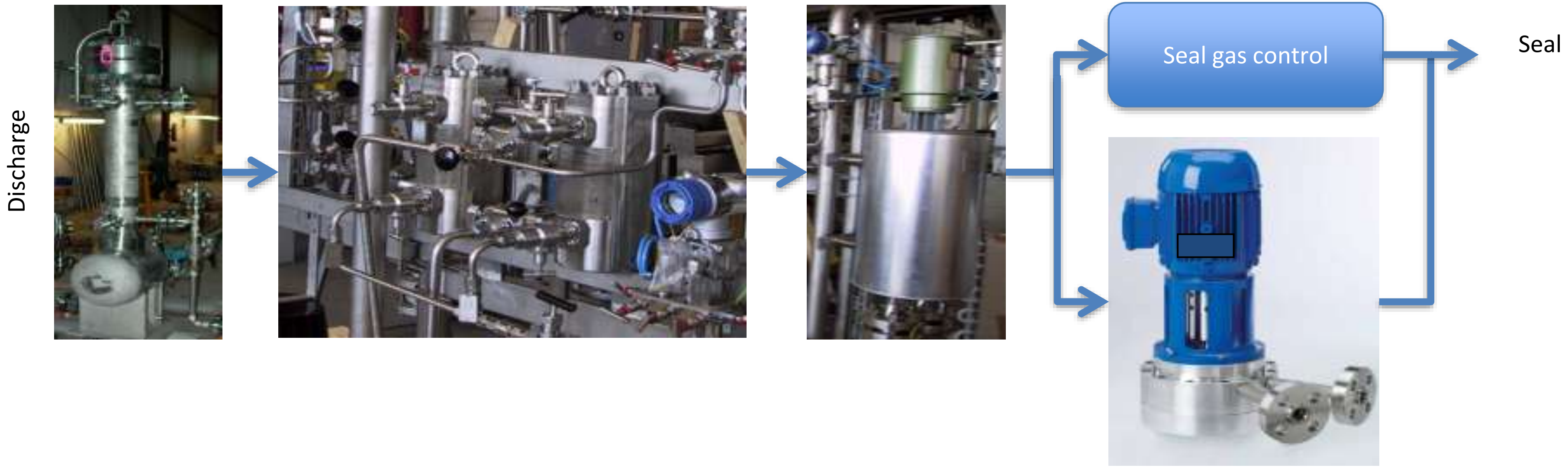


Contamination during pressurized hold



- Higher pressure source
- Proper quality at the inlet
- Considering potential cooling / condensation during transport

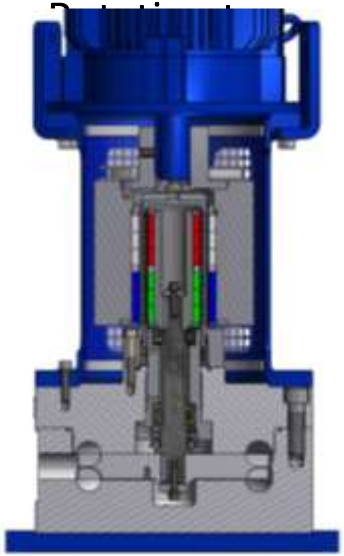
Seal Gas Conditioning



- Depending on the gas quality certain components are required to treat the gas
- Potential elements are coolers, knock out drum, heater, heat trace and the gas booster
- Such skids could be included in existing skids or kept separate

Booster types – working principle

Rotating Booster

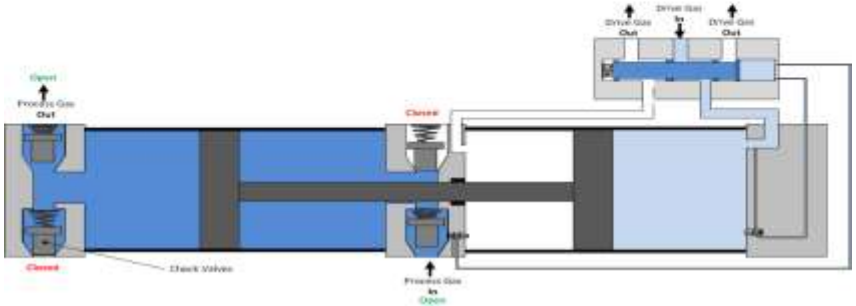


System need:

- Booster in bypass
- Valve to close bypass

- Power

Piston Booster



System need

- Booster in bypass
- Valve to close
- Buffer vessel (to reduce pulsation)
- Air supply
- Vent (of leakage)

Booster types – limits / opportunities

Rotating Booster

Limits

- High Δ p at low pressures
- Needs certain flow for cooling during operation
- Electrical driver
- Needs to bypass restrictions

Opportunities

- Extended lifetime
- Hermetically sealed
- Electrical driven
- Focusses on generating the flow required

Piston Booster

Limits

- Lifetime
- Flow / machine
- Air driven

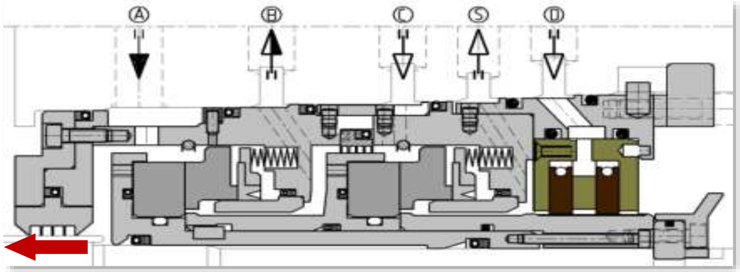
Opportunities

- Higher Δ p at low pressure
- In line with throttles (e.g. valves)

Booster types – flow

Requirement → gas velocity @ PS laby

e.g. 778 Nm3/hr (458 scfm) per compressor (2 seals)



Solution	Required machines	Output (seal gas flow)	Input (energy)
Piston type Booster	3	996 Nm3/hr	187,8 Nm3/hr air
Centrifugal Booster	1	780 Nm3/hr	6-7 KW energy

Case study conditioning skid - booster

Situation:
Combined power cycle gas plant, Argentina

→ Repeated seal failures

Root cause:
Seals found contaminated by process gas. Contamination was routed back to no seal gas flow to the seals during pressurized hold

Mitigation:
Implementation of a rotating booster skid to ensure reliable seal gas flow at any operating condition, also during pressurized hold.

Experience:
Improvement of MTBF from 1-3 years to MTBM (no failure)

Case study robust seal

Situation:
Natural gas processing plant, Australia
Gas transport to LNG plan
→ Repeated seal failures

Root cause:
Seals found contaminated with liquid, which was routed back to TEG used in the dehydration process and residues found the way into the seals.

Mitigation:
Upgrade of standard DGS to robust DGS being able to handle more contamination.

Experience:
Improvement of MTBF from 2-6 month to MTBM (no failure)

Overview seal gas contamination & countermeasures

Root cause	Solutions	Selection
Seal contamination by - Particles - Fluids - Condensates **Because of** - Poorly Conditioned Seal Gas - Dirty Process Gas - Not enough seal gas flow, especially during pressurized hold	**Seal gas conditioning** → Cooler, KOD, Heater → Filter, Coalescer → Seal gas booster	→ Eliminates the source → Complex to upgrade → Modification on system needed → Time for implementation implement
	Robust seal design → Upgrade of existing DGS to make it more robust against contamination	→ Does not address the source → Easy implementation (modified seal only)

Any questions?